



## **Philosophical Transactions**

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*Mr. Isaac Newton's Considerations on the former Reply; together with further Directions, how to make the Experiments controverted aright: Written to the Publisher from Cambridge, Novemb. 13: 1675.*

SIR,

When you shew'd me Mr. *Line's* second Letter, I remember I told you, that I thought an answer in writing would be insignificant, because the dispute was not about any Ratiocination, but my veracity in relating an Experiment, which he denies will succeed as it is described in my printed Letters: For this is to be decided not by discourse, but new tryal of the Experiment. What it is that imposes upon Mr. *Line* I cannot imagin; but I suspect he has not tryed the Experiment since he acquainted himself with my Theory, but depends upon his old notions taken up before he had any hint given to observe the figure of the coloured Image. I shall desire him therefore, before he returns any answer, to try it once more for his satisfaction, and that according to this manner.

Let him take any Prism, and hold it so that its Axis may be perpendicular to the Sun's rays, and in this posture let it be placed as close as may be to the hole through which the Sun shines into a dark room, which hole may be about the bigness of a Pease. Then let him turn the Prism slowly about its Axis, and he shall see the colours move upon the opposite wall first towards that place to which the Sun's direct light would pass, if the Prism were taken away, and then back again. When they are in the middle of these two contrary motions, that is, when they are nearest that place to which the Sun's direct ray tends, there let him stop; for then are the rays equally refracted on both sides the Prism. In this posture of the Prism let him observe the figure of the colours, and he shall find it not round as he contends, but oblong, and so much the more oblong as the Angle of the Prism, comprehended by the refracting plains, is bigger, and the wall, on which the colours are cast, more distant from the Prism; the colours red, yellow, green, blew, purple, succeeding in order not from one side of the figure to the other, as in Mr. *Line's* conjecture, but from one end to the other; and the length of the Figure being not parallel but tranverse to the Axis of the Prism. After this manner I used to try the Experi-

ment: For I have try'd it often; sometimes to observe the circumstances of it, sometimes in order to further Experiments, and sometimes to show it to others, and in all my tryals the success was the same. But whereas Mr. *Line* thinks, I tryed it in a cloudy day, and placed the Prism at a great distance from the hole of the window; the Experiment will not succeed well if the day be not clear, and the Prism placed close to the hole, or so near at least, that all the Sun's light that comes from the hole may pass through the Prism also, so as to appear in a round form if intercepted by a paper immediately after it has past the Prism.

When Mr. *Line* has tryed this, I could wish, he would proceed a little further to try that which I call'd the *Experimentum Crucis*, seeing (if I mis-remember not) he denies that as well as the other. For when he has tryed them (which by his denying them, I know he has not done yet as they should be tryed) I presume he will rest satisfied.

Three or four days after you gave me a sight of Mr. *Line*'s second Letter, I remember I thereupon shew'd the first of these two Experiments to that Gentleman whom you found with me, when you gave me that visit, and whilst I was shewing it to him, *A.H.* (a member of the *R. Society*) came in and I shewed it to him also. And you may remember, that *R.H.* two or three years agoe in a Letter read before the *R. Society*, and transmitted to me, gave testimony not only to the Experiments questioned by Mr. *Line*, but to all those set down in my first Letter about Colours, as having tryed them himself; and when you read Mr. *Line*'s Letter at a meeting of the said *Society*; and was pleas'd to do me the favour to propound the Experiment to be tryed in their presence, *R.H.* spake of it to them as a thing not to be questioned. But if it have not yet been tryed before them, and any of them, upon Mr. *Line*'s confidence, doubt of it, I promise when I shall have the happiness to be at any more of their Assemblies, upon the least hint, to shew 'em the tryal of it; and I hope, I shall not be troublesome, because it may be tryed (though not so perfectly) even without darkning a room, or the expence of any more time than half a quarter of an hour; although, if Mr. *Line* persist in his denial of it, I could wish it might be tryed sooner there, than I shall have an opportunity to be among them.

*An Extract of another Letter of Mr. Newton, written to the Publisher the 10th of January 167 $\frac{1}{2}$ , relating to the same Argument.*

— BY Mr. Gascoine's Letter \* one might suspect, that Mr. Linus tryed the Experiment some other way than I did; and therefore I shall expect, till his friends have tryed it according to my late Directions. In which tryal it may possibly be a further guidance to them, to acquaint them, that the Prism casts from it several Images: *One* is, that *Oblong* one of *Colours* which I mean; and this is made by two Refractions only. *Another* there is, made by two Refractions and an intervening Reflexion; and this is *Round* and *Colourless*, if the Angles of the Prism be exactly equal; but if the Angles at the Reflecting base be not equal, it will be *colour'd*, and that so much the more, by how much unequal the Angles are, but yet not much *unround*, unless the angles be very unequal. A *third* Image there is, made by one single Reflexion, and this is always *round* and *colourless*. The only danger is in mistaking the *second* for the *first*. But they are distinguishable not only by the Length and Lively colors of the *first*, but by it's different Motion too: For, whilst the Prism is turned continually the same way about it's *axis*, the *second* and *third* move swiftly, and go always on the same way till they disappear; but the *first* moves slow, and grows continually slower till it be stationary, and then turns back again, and goes back faster and faster, till it vanish in the place where it began to appear.

\* This Letter was written to the Publisher, Decemb. 15. 1675. from *Leige*, where Mr. Gascoine, having been a Scholar of Mr. Linus, now deceased, resides. In it are contained these words, to which Mr. Newton, to whom it was communicated, seems here to have respect; viz. Mr. Linus tryed the Experiment again and again, and called divers on purpose to see it, nor ever made difficulty to shew it to any one, who either by chance came to his chamber as he was doing it, or shew'd the least desire to see the same. So that, for point of Experience, Mr. Newton cannot be more confident on his side, than we are here on the other; who are fully persuaded, that, unless the diversity of placing the Prism, or the bigness of the Hole, or some other such cir-

cumstance, be the cause of the difference betwixt them, Mr. Newton's Experiment will hardly stand.

If without darkning their Room they hold the Prism at their window in the Sun's open Light, in such a posture that it's *axis* be perpen

perpendicular to the Sun-beams, and then turn it about its *axis*, they cannot miss of seeing the *first* Image; which having found, they may double up a paper once or twice, and make a round hole in the middle of it about  $\frac{1}{2}$  or  $\frac{3}{4}$  of an inch broad, and hold the paper immediately before the Prism, that the Sun may shine on the Prism through that hole; and the Prism being stay'd, and held *steady* in that posture which makes the Image Stationary; if the Image then fall directly on an opposite wall, or on a sheet of paper placed at the wall, suppose 15 or 20 foot from the Prism, or further off; they will see the Image in such an *Oblong* figure as I have described, with the *Red* at one end, the *Violet* at the other, and a *Bluish green* in the middle: And if they obscure their Room, as much as they can, by drawing curtains or otherwise, it will make the Colours the more conspicuous.

This direction I have set down, that no body, into whose hands a Prism shall happen, may find difficulty or trouble in trying it. But when Mr. *Linus*'s friends have tryed it thus, they may proceed to repeat it in a dark Room with a *less* hole made in their window shut. And then I shall desire, that they will send you a full and clear description, How they tryed it, expressing the length, breadth and angles of the Prism; its position to the Incident rays and to the window shut; the bigness of the hole in the window shut through which the Sun shined on the Prism; what side of the Prism the Sun shin'd on; and at what side the light came out of it again; the distance of the Prism from the opposite paper or wall on which the Refracted light was cast perpendicularly; and the length, breadth, and figure of the space there illuminated by that light, and the situation of each colour within that figure. And, if they please to illustrate their description with a Scheme or two, it will make the business plainer. By this means, if there be any difference in our way of experimenting, I shall be the better enabled to discern it, and give them notice, where the failure is, and how to rectifie it. I should be glad too, if they would favour me with a description of the Experiment, as it hath been hitherto tryed by Mr. *Linus*, that I may have an opportunity to consider, what there is in that which makes against me.

So far Mr. Newton; which was thought fit to make publick with the rest, that so the Curious every where, who have a mind to try the Experiment, may find the fuller directions for their tryal.